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THE STATUS AND FUTURE OF AEROSPACE ENGINEERING EDUCATION IN TURKEY

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ABSTRACT

There is no aerospace industry in Turkey and the level of operational activity is low even though the potential for the exploitation of aviation is high. The government of Turkey hopes to establish an aircraft factory in conjunction with a foreign contractor and is aware of the need for aerospace engineering education. This paper describes the efforts and plans of the Middle East Technical University to develop a phased and evolutionary curriculum that will satisfy the needs and priorities of the country.

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Turkey is a country slightly larger in area than Texas and with a population or the order of 35 million people. Located at the eastern end of the Mediterranean Sea, it straddles Europe and Asia, lying principally in Asia. The eastern portion of the country is quite mountainous and shares borders with the Soviet Union, Iran, and Iraq. The southeastern Syrian border of 400 miles is its largest land border. The European portion of Turkey borders on Bulgaria and Greece.

The economy has been traditionally and predominantly agricultural (characterized by small farms, hand labor, and the absence of machinery) along with some mining and processing activity. In recent years the Republic of Turkey has been undergoing a large industrial expansion as well as a modernization of its agricultural techniques. Unfortunately however, the overall transportation system, which was initially inadequate, has been unable to keep pace and there are elements and subsystems which may never prove to be adequate. For example, all ground traffic to and from the European markets and sources must cross the Bosporus at Istanbul, which lies in both Asia and Europe. Two years ago, the first and only vehicular bridge across the Bosporus was completed; railway traffic must still cross on ferries and barges. At present, and for the foreseeable future, there are only one highway and one railway line from Istanbul to Europe and these pass through Bulgaria and Yugoslavia. Furthermore, since Turkey is at the shallow end of the Mediterranean ocean-going ships with deep draft must pick up or off-load cargo at a deepwater port in Italy or Greece.

Within Turkey surface transportation consists of rail, "highways," and intercoastal shipping. The state of the rail system can be illustrated by stating that there is only a single track connecting Istanbul and Ankara,

the capital, and that the scheduled time for the daily passenger express train to cover the 250 miles is 12 hours. Five days must be allowed for a freight shipment between these two cities. There is a comparatively large number of buses and trucks in Turkey but the roads have not been developed. The main highway, E-1, again connecting Istanbul and Ankara is two-lane only and the trip is both terrifying and dangerous.

This is a country that appears to be in an excellent position to use and exploit aviation and its supporting technologies. In actuality, however, there is no aircraft industry whatsoever and the major commercial operation is that of the Turkish Airlines (THY), which is government owned and operated. THY emphasizes international passenger flights, using DC-9's and DC-10's. Domestic travel is very restricted, both in frequency and the number of cities served. Foreign carriers are few in number and limited to passenger flights through Istanbul with an occasional turnaround at Ankara. Air cargo is virtually non-existent.

There is no private or general aviation per se and the only non-commercial or non-military flying is carried out by the Turkish Aviation Association, a government flying club with a few small twin-engine propeller aircraft. At present the only military aircraft are those provided by or purchased from the U. S. Government.

The absence of any industry and the low activity level should not be construed as a lack of interest in aviation on the part of the Turkish people and government. On three occasions, Turkey has started an aircraft industry only to see her efforts fail. The first venture was in 1923, building a twin-engine light bomber-transport of the scale of a large twin-Beech in a factory outside of Ankara. Sales were disappointing and

the factory was closed. An attempt in the early 1930's for a joint enterprise with the Germans foundered because of conflicting views as to the objectives and control of the undertaking. After World War II, a factory was built at Kayseri and was producing a single-engine biplane trainer, whose performance was out-dated and unacceptable to the Turkish Air Force and to any other potential customer. The production line was shut down in 1947 and the facility converted to a maintenance and overhaul activity, functions it has been performing since.

Over the past few years there has been a resurgence of interest in establishing an aircraft industry in Turkey, simulated by a desire on the part of the military not only to reduce its complete dependence on other countries for its aircraft but also to improve its understanding of the capabilities, limitations, and trade-offs involved in the design and operation of such aircraft. To rephrase the last phrase, the Turkish Air Force wants to educate itself to the point where it can match its military needs and performance requirements to those of the aircraft, either available or to be produced.

The moving force behind this latest move is the Turkish Air Force Foundation, a quasi-governmental organization, funded by public contributions and special amusement taxes, that is closely linked to the Turkish Air Force. The Foundation, in conjunction with the Air Force, determined that the most useful aircraft to meet Turkey's defensive needs would be one with the ability to: accomplish a high-altitude supersonic intercept, execute a combat air patrol, engaged in subsonic aerial combat with guns (after launching missiles), and carry out a low-level penetration and bombing attack against airfields and military targets. Based

on these performance specifications, proposals were solicited from foreign aerospace industry contractors to construct an assembly plant and co-produce, with a newly-formed Turkish aircraft company called TUSAS, a total of 200 fighter aircraft, already designed and operational. As of July 1974, the semi-finalists appeared to be Northrop with its F-5E and Lockheed with the F-104G, and the announcement and award of contract were expected shortly. Then came the Cyprus situation and the present status of and plans for TUSAS, are not shown.

The Foundation was aware of the fact that it as only buying a production facility, not an engineering design capability and was concerned with the fate of the factory at the completion of the production run. What should be the second aircraft to be produced (possibly a short-range feeder airlines for domestic use) and what supporting industries can and should be developed were only two of the questions worrying the Turks.

Spurred by this activity and encouraged by both the Foundation and the Turkish Air Force, the Middle East Technical University (METU) at Ankara, is attempting to develop an aerospace engineering capability. METU was founded in 1956, is patterned in the American tradition and curricula, and uses English exclusively as the language of instruction. The students and faculty are of high quality and almost all of the latter have obtained their doctoral degrees at universities in the U.S., Canada, England, or Germany.

The Mechanical Engineering Department is the principal agency of METU in the development of an aerospace engineering curriculum. Although there is a strong capability in the fundamentals, such as fluid flow, mechanics, thermodynamics, heat transfer, controls, and materials and

structures, there is a lack of specific knowledge of aerospace engineering and its applications. Furthermore, the lack of a market for aerospace engineers, budgetary limitations, and existing proprities for engineering graduates do not justify the creation of a full-blown and complete curriculum as we know it. Not only is such a curriculum with its ten or so specialized courses and laboratories expensive with respect to money and teaching resources but it is also expensive with respect to time required to turn out a useful product. In addition, the pressing need in Turkey at present is not for aerospace engineers as such but for people who understand the capabilities, limitations, and cost of various aircraft configurations, for people who can determine for themselves what types of aircraft are needed and who will not be dependent on the friendly aircraft salesman from out of town. The immediate need is for people who can do preliminary performance analyses and feasibility design studies but not necessarily design a wing, engine, or undercarriage. The single course in the traditional curriculum that comes closest to providing this capability is the performance course, which is generally offered late in the curriculum after meeting aerodynamic and propulsion prerequisites.

It was decided at METU to invert the curriculum and ME 477 "Introduction to Aircraft Performance and Design" was offered for the first time in the Spring of 1974. There were no formal prerequisites, it was offered as an elective, and there were 52 officially registered students, including members of the technical staff of the Turkish Air Force Foundation and officers of the Turkish Air Force. Emphasis was on quasi-steady-state flight, on best performance as a figure of merit, and on the relationships among design characteristics, flight conditions, and performance.

The black box approach was used for aerodynamics, propulsion, and structures, e.g., parabolic drag polars, thrust-to-weight ratios, specific fuel consumption, weight fractions were used to represent various types of aircraft. The students determined the preliminary configuration of a 20 passenger jet-powered feeder airliner and discovered why aerial combat may start at 50,000 feet at Mach No. 3 but if prolonged without a kill will eventually descend and become subsonic. The course was well-received and the Air Force has approached METU with the objective of establishing a formal program for some of its officers along with special short courses.

The development of an aerospace engineering curriculum at METU is following two parallel paths that are interrelated yet independent. The first path might be called the immediate or inverted curriculum and will be principally flight mechanics courses. The first course is the performance course just described. As the demand arises, a second course on stability and control will be added to complete the preliminary design and feasibility sequence. A third course might well be navigation and avionics or a design course.

The second path is the development of the supporting technical courses in aerodynamics, propulsion, and structures along traditional lines. At the present time, METU has two wind tunnels under construction and the use of one extramural tunnel, a new aerodynamics faculty member, and several instructors on leave completing their doctoral studies in aerodynamics at British and American universities. Formal courses in aerodynamics will be offered soon as technical electives in the senior year, along with the first path courses. It is anticipated that

that propulsion and aircraft structures courses will be developed and offered as the need, demand and capability all materialize.

As the number of courses increases, so does the possibility of offering aerospace engineering to the students as a formal option to the B.S. in Mechanical Engineering. If acceptance of the program and of the graduates is sustained, the next logical step would be a full-fledged aerospace engineering curriculum. It is anticipated that the "Introduction to Aircraft Performance and Design" course will be maintained as the first course to be taken, inasmuch as it is an overview course that makes the student aware of why aircraft look and fly as they do and also provides motivation and direction to him when and if he takes technical specialization courses.

In summary, the aerospace engineering program at METU at present comprises one course, wind tunnel construction and associated preparation for aerodynamics course(s), and a conceptual approach for further curriculum development that offers the following advantages:

1. No large initial commitment of resources is required and there is no need to make great promises.

2. Each course is essentially self-sufficient and can be added as desired. The course can initially serve as an elective (often as an application of a fundamental theory course(s)) and be either terminal or part of a sequence, depending upon the student's program.

3. The speed at which the curriculum is developed can be easily controlled. In fact, the development can be arrested at any point for any period of time desired. Furthermore, the

program can be reduced or even cancelled with a minimum of trauma if circumstances so indicate.

METU and Istanbul Technical University are the two major universities with engineering schools in Turkey; Boğazici University (formerly Roberts College) is much smaller and primarily undergraduate. Regional universities with engineering departments are being established along with academies, the equivalent of our junior and community colleges. There is a shortage of qualified faculty and at present key staffing in the engineering areas is by visiting faculty from Istanbul Tech and METU. Istanbul Tech is a long-established university structured in the European tradition with chairs rather than an ordered curriculum. There is an aeronautics option with approximately 20 students and with emphasis on structures and aerodynamics rather than performance and design.

Although the status of aerospace engineering in Turkey is minimal and activity at a low level by our standards, the desire and fundamental skills and knowledge are there. There are hopes and plans for the future but also uncertainty.